HiPiP
(ITEA 2 07022)

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High performance computing advances cut healthcare costs

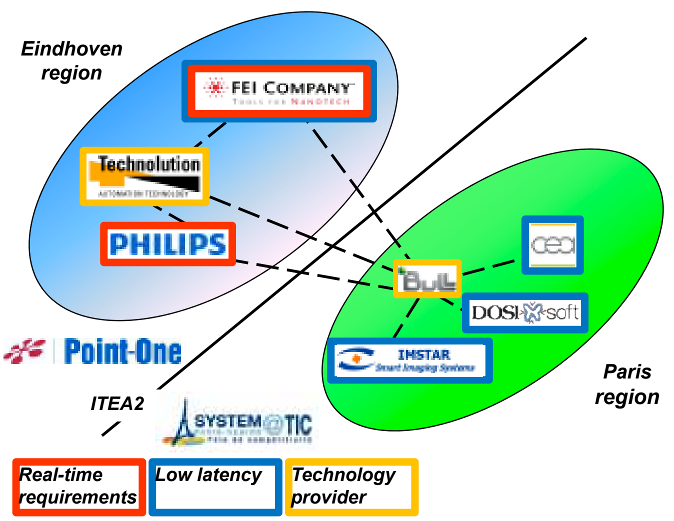
The ITEA 2 HiPiP project has developed affordable high-tech medical image-processing applications based on high performance computing multicore, multiprocessor technologies. Innovations include improved throughput times with reduced latency and jitter from parallelisation, lower hardware costs and reduced development times from use of standard hardware, and the possibility of 3D template matching. Applications are ready for exploitation in minimally invasive surgery, automated medical screening, radiotherapy scheduling and aging research.

Real-time image processing is of increasing importance in healthcare – particularly for minimally invasive operations, automated screening and medical research. While modern imaging can provide ever more detail, this has resulted in massive amounts of data to be processed. The focus of HiPiP was to apply parallel processing technologies to make faster use of this information – ideally in real time. Similar problems arise in other sectors where vast amounts of heterogeneous data have to be processed quickly.

Key applications of faster 2-, 3- and 4-D – space and time – images were seen as detailed brain imaging, minimal invasive surgery, real-time radiation therapy planning, mass screening for early cancer detection and faster operation of high resolution transmission electron microscopes.

AFFORDABLE MULTICORE PROCESSING

The main problem was to deal with multicore processing in an affordable way with special attention to medical-image processing. French computer maker Bull and Netherlands-based Philips Healthcare therefore decided to combine forces in a collaborative ITEA 2 project involving two complementary national competitiveness clusters: System@tic in France and Point-One in the Netherlands.



Bull had lot of knowledge about parallelism and was keen to adapt its high performance computing multicore, multiprocessor technologies to time-critical and demanding applications in new areas. Philips wanted to increase the speed of image processing while reducing the cost of its medical-imaging equipment.

Key HiPiP objectives included:

- Reducing complex image-processing latency to enable immediate use of image information – for example in minimally invasive surgery where it allows a surgeon to manipulate complex equipment inside the body while receiving a real-time view;
- Enabling high throughput image processing to handle very large and heterogeneous data sets – such as providing effectively supercomputers on the desktop while increasing the breadth of research studies;
- Predictable short image-processing times for

medical operations and diagnosis, and for the use of high resolution instruments; and
- Providing inexpensive solutions for complex tasks – applications, systems and networks as well use of standard hardware solutions.

All this required the development of new algorithms and dealing with process scheduling and memory access not normally carried out in traditional operating systems. Results were well up to expectations with improvements in algorithms offering up to 30% more throughput, 50% lower latency and 20% less jitter. Server-based support was also developed to allow massive image processing, enabling for example project partners FEI and CEA to obtain reductions in processing time of up to 97%.

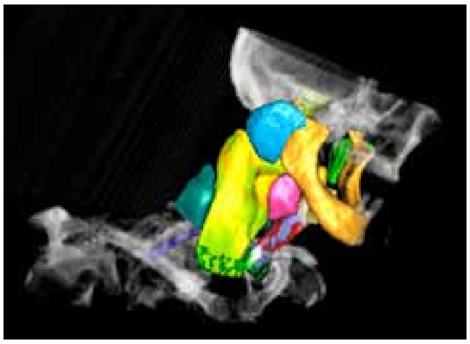
Introduction of advanced management of computing resources or virtualisation made it possible to carry out background and real-time processing on the same hardware. This enabled Philips, for example, to achieve a more than 50% reduction in process hardware costs in its medical-imaging systems – equivalent to €2,000 per system. Previously, each kind of image needed its own processor, with another processor for all kinds of background tasks. The aim was to combine real-time and non real-time processes on the same hardware to reduce equipment costs. This involved improvements to scheduling and memory access.

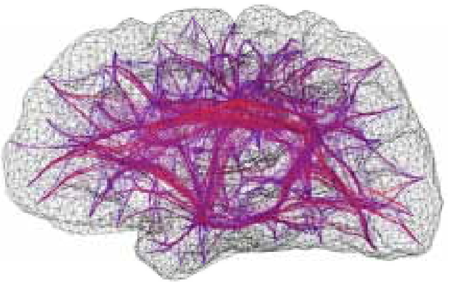
MARKETABLE PRODUCTS IN PIPELINE

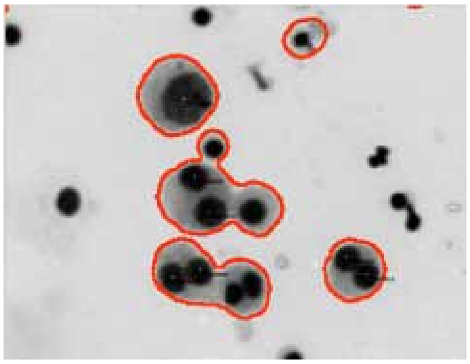
Significant progress was achieved in the ITEA 2 project, enabling four of the partners to be able already to launch a series of different products on the market in 2012 based on HiPiP results.

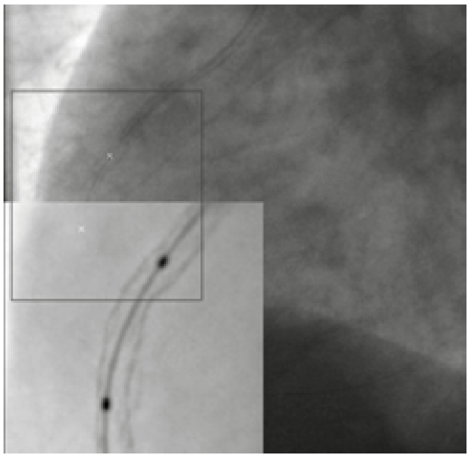
For Philips, HiPiP has not only increased speeds but also improved real-time aspects of multicore processing – particularly the predictability of images being be shown in a very short time with little variation in the time taken to process the images. This now enables a doctor to see an image taken a tenth of a second earlier, allowing much improved hand-eye co-ordination when using advanced image processing during surgery.

Such an approach is crucial for minimally invasive surgery where the doctor has to look at the screen to see what he is doing because the equipment is somewhere in the body of the patient. The information needs to be processed quickly while reducing noise in the image and enhancing elements which are important for the doctor to see. Moreover, it is now also possible to make much better images while at the same time reducing patient exposure to X-rays.









Electron microscopy specialist FEI has increased speeds by a factor of more than 100 using novel algorithms in combination with graphical processing units with hundreds of cores in their post-processing workstations – reducing processing time from hours to minutes.

CEA in France had been carrying massive brain scan studies for Alzheimer's disease research with processing time for one image as long as a week. The results of HiPiP have now reduced this to several hours. This means that much more can be done – for example several images can be taken from one person for comparison. This will play an important role in future medical research. The resulting algorithms will also have clinical applications.

French partner DOSIsoft is involved in planning for oncology radiotherapy which needs to be fast as the body is moving and the cancer growing. Best targeting of treatment requires imaging of the cancer an hour before therapy treatment but this was impossible before. HiPiP has now made it possible, cutting the time for required imaging to only 20 minutes. Skilled manpower resources are also reduced as the process can be partially automated – before a doctor was needed to indicate the organs seen on the screen.

Automated digital imaging specialist IMSTAR has been able to make a step change from manual to automated high-throughput medical screening systems, enabling improved performance at a reasonable price. While an algorithm existed for automation, processing took too much time. Automated tissue and cellular imaging can now be run continuously with only unusual cases having to be referred back to a doctor.

Bull itself has made important advances with new application domains and market targets for high performance computing. It has extended its systems with real-time capabilities for image processing and other time-critical applications. And it now has a scalable real-time high performance computing infrastructure ready for use in other commercial projects.

COMMERCIAL AND MEDICAL BENEFITS

Overall the project was a major success with a limited number of organisations working well together with clear goals and marketable results. HiPiP has boosted Europe's position on the global stage with a greater understanding of real-time parallel processing. And it has brought about important benefits in patient care through faster, more targeted treatment and reduced X-ray exposure.

MORE INFORMATION:

http://hipip.eu